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PERFORMANCE ANALYSIS OF HWMP AND A NEW MIMC PROTOCOL IN WLAN MESH NETWORKS

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ABSTRACT

Wireless Mesh network provides great support for modern communication. In Mesh networks, various channel and interfaces are used for fulfilling the requirement of users. WLAN mesh networks have been widely used for military scenarios, residential areas, campus/public access and remote areas. Particularly, we have single interface, single channel(SISC) for communication. Moreover, multi interface, multi channel(MIMC) also provide huge resources now days. Utilizing multi-interfaces and multi-channels (MIMC) is essential in increasing capacity and performance of emerging wireless mesh networks. In this paper, we proposed a new MIMC routing protocol which is fullycompatible with HWMP protocol. Hybrid Wireless Mesh Protocol (HWMP) defined in 802.11s is a basic routing protocol for a wireless mesh network. It is based on AODV and tree-based routing. The proposed work signifies that channel diversity is the prime factor for the throughput of the path. Path selection algorithm basically utilizes the same path discovery mechanism of the HWMP and the airtime link metric to maintain compatibility. In our research, we will also focus on the reduction of control message overhead by providing timely arranged intervals. We will control the flow of the communication with experimentation of Single Channel Single Interface and Multi Interface Multi Channel Schemes.

KEYWORDS: Wireless Mesh Network, Multiple Interfaces and Multiple Channels (MIMC), HWMP

INTRODUCTION

Wireless mesh networks provides a new area of technology set to play an important role in the next generation wireless mobile networks and it is going to address the internet provision to user at low cost anytime from anywhere. With a limited transmit power; it has an ability to cover a wide geographic area. A WMN has several favourable features such as dynamic self-healing, self organizations, self configuration, with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves (creating, in effect, an ad-hoc network). It provides easy maintenance, high scalability and reliable services. A WMN is different from a mobile ad hoc network as it depends on a high-speed back-haul network which is composed by WMN routers. By using multiple radios, WMN optimizes network performance [2]. A WMN can provide gateways to the wired internet and other wireless services. Due to its unique mesh structure, a WMN has an advantage over traditional MANET and wireless local area network in the areas of extensibility, reliability, data throughput and ant jamming. WMN has been considered as a cost-effective approach to support high-speed last mile connectivity and ubiquitous broadband access in the context of home network, enterprise networking, community networking, or metropolitan area network. The IEEE standard for mesh networking started as a Study Group of IEEE 802.11 in September 2003.Moreover with various properties of WMN like-with minimal up-front investment and being easily adjustable and expandable, wireless mesh networks cater to the requirements of various consumers whether large or small[3]. Even though considerable research efforts are still needed, with all these advantages, wireless mesh technology will open a world of possibilities and develop a burgeoning market in the foreseeable future.

MULTIPLE INTERFACES AND MULTIPLE CHANNELS

Wireless network technology has been extremely useful in mobile communication and computing application .But although it suffers from overheads of packet loss, packet errors, contention, low link-layer data rates and packet headers. It drastically reduce the actual goodput available to the wireless network applications. With increasing distance between signal source and destination, the data rate also falls quickly. Interference from adjacent hops in a multi-hop network further decreases the available bandwidth. By using multiple channels thus removes both of the problems – as it extends the available bandwidth and removes the problem of interference by providing simultaneous communication between adjacent hops on a non-overlapping channel[1]. As it has a wireless backbone, it is very challenging to improve the network capacity by providing the required quality of network services to as many users as possible. A preferred solution is to integrate multiple radio interfaces into a mesh router. As different channels are assigned with multiple interfaces, it can simultaneously transmit packets without interference [5]. Moreover, we can easily make a multi-interface based mesh router with cost effectiveness using inexpensive off-the-shelfWLAN cards. Multi-radio and multi-channel architecture has special usage in the wireless mesh networks (WMN) [6]. In a mesh network, nodes act as repeaters to transmit data from nearby nodes to distant nodes in the network. Their special usage is in case of providing an inexpensive last mile broadband internet connectivity. In some cases the mesh may be serving as an extension to a wired backbone, thus decreasing the need of a dense physical wire network and hence the cost of maintenance.

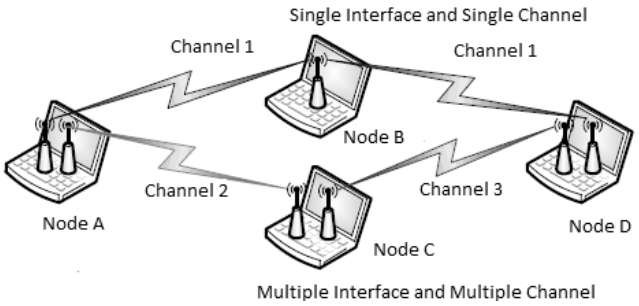

Figure 1: Comparison of SISC and MIMC Paths

We also need a channel assignment algorithm which provides schedules assignment and coordinates between the nodes . It can also provides switching of channels among the NICs to utilize multiple channels, if necessary. Channel assignment algorithm needs to adhere to certain demands of the network for gaining maximum benefit. Specifically, the proposed CA schemes can be divided into three main categorie- fixed, dynamic, and hybrid depending on the frequency with which the CA scheme is modified. In a fixed scheme the CA is almost constant, while in a dynamic scheme it is continuously updated to improve performance. A hybrid scheme combines the properties of both fixed and dynamic as itapplies a fixed scheme for some inter-faces and a dynamic one for others[3].

HYBRID WIRELESS MESH PROTOCOL(HWMP)

IEEE 802.11s specifies the Hybrid Wireless Mesh Protocol (HWMP) as the mandatory and default Path Selection protocol. It combines the features and flexibility of on-demand route discovery with efficient proactive routing to a mesh portal. HWMP protocol has following elements :- Root Announcement(broadcast), Route Request(broadcast/unicast), Route Reply(unicast), Route Error(broadcast). HWMP supports two modes :-On-demand mode (proactive) and proactive tree building mode.

On-demand mode allows nodes in mesh network to communicate with each other by creating peer-to-peer paths on the basis of the AdHoc On-Demand Distance Vector (AODV) [1]. But, unlike AODV, it works at layer 2. It uses three

different types of management frames :- Path Request (PREQ) Path Reply (PREP) and Path Error (PERR). Its main features are-On demand routing, route discovery, route maintenance and loop freedom.In this scheme, firstly a source node that does not have a valid path to the destination initiates Path Request (PREQ) broadcasting. Upon receiving a PREQ, the destination node sends a unicast Path Reply (PREP) message back to the source. Intermediate nodes which have forwarded PREQ and PREP messages update their own path table to relay data packets between the source and the destination.

In the proactive tree building mode, one node in the mesh network act as a root node. It maintains a tree path from the root node to all the other nodes. Its main features are :- Topology creation and Topology maintenance. The proactive tree building mode is the extension of the on-demand mode. There are two sub-mechanisms of proactive tree building mode :-Proactive PREQ mechanism and Proactive RANN mechanism. The first method which is proactive PREQ begins with sending a proactive PREQ message periodically by the root node. The target of the proactive PREQ is tobroadcast MAC address to all other nodes. It means that every mesh node has to respond to the received PREQ by sending a PREP back to the root node. The second method is the Proactive RANN mechanism, in this a root node periodically broadcasts Root Announcement (RANN) messages to the entire network[4]. Upon receiving a RANN, each mesh node can select whether or not it creates a path towards the root, which is different compared to the proactive PREQ method. A node that wants to create or refresh the path sends a unicast Path Request(PREQ) message to the root and it is in succession responds by sending a unicast Path Reply (PREP) message.

PROPOSED SCHEME

In this section, we will proposed a new routing protocol ‘HWMP’ in the NS2 environment which is suitable in MIMC environment. The proposednew MIMC routing protocol is fully comptiable with HWMP protocol for requisite selection of path on the basis of SISC and MIMC. The proposed path selection algorithm basically utilizes the same path discovery mechanism of the HWMP and the airtime link metric to maintain compatibility. We will first analyze how theHWMP works in SISC environment and then we will introducedourproposed technique that works in MIMC environment.

We arrange the mesh nodes in the particular fashion so that it can fullfill the requisite simulation of HWMP. Then we implement a new routing protocol with the requisite parameters and we will attach link cost and channel number at the end of PREQ/RREQ and PREP/RREP message format to improve the path throughput. To reduce the control message overhead, we will increase the time interval of the PREQ/RREQ forwarding packets according to the dijkstra's algorithm which is based tottaly on the path selection of the neighbouring nodes and also depends upon the number of increased time intervals which we improved for our proposed HWMP routing protocol. Then firstly, we introduce the communication in SISC environment as some of the user nodes can transmit packets using single channel and single interface to the destination. By this procedure, HWMP frequently changes the path and it lead to degradation of the throughput, which causes path instability problem of the HWMP. In the next step, we introduce the communication in MIMC environment as someof the other nodes can transmit packets using multiple channels and mutilple interfaces to the destination. The Dijkstra’s algorithm is implementedover the whole proposed routing protocol through which the actual communication and broadcasting can be done and further all requisite work mainted through the algorithm

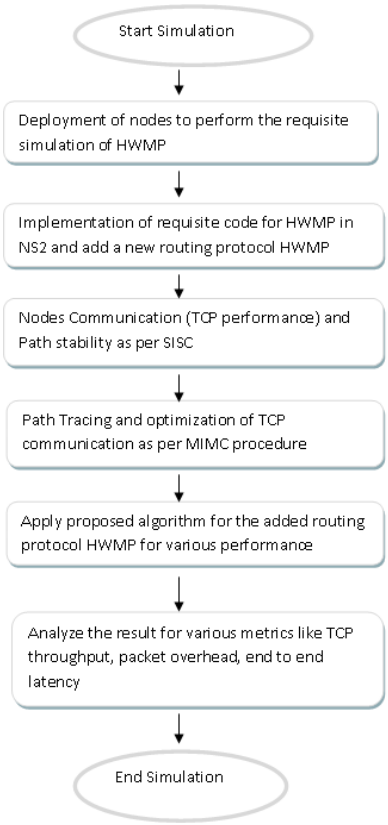

Figure 2: Flow Chart

As Dijkstra's algorithm is a graph search algorithm that solves the single-source shortest path problem for a graph with non-negative edge path costs, producing a shortest path tree. This algorithm is often used in routing and as a subroutine in other graph algorithms. Dijkstra's algorithm is used to reduce the network overhead as it increases the time interval of the PREQ forwarding message, so packets drop wil be reduced.

Algorithm

Let the node at which we are starting be called the *initial node*. Let the *distance of node Y*be the distance from the *initial node* to *Y*. Dijkstra's algorithm will assign some initial distance values and will try to improve them step by step.

- Every node is assigned by a tentative distance value : set it to zero for our initial node and to infinity for all other nodes.
- All nodes are markedunvisited. Set the initial node as current node. Create a set of the unvisited nodes called the unvisited set consisting of all the nodes.
- Start from the current node, consider all of its unvisited neighbors and calculate their *tentative* distances.
- When we are done considering all of the neighbors of the current node, mark the current node as visited and remove it from the *unvisited set*. A visited node will never be checked again.
- If the destination node has been marked visited or if the smallest tentative distance among the nodes in the *unvisited set* is infinity , then stop. The algorithm has finished.
- Select the unvisited node that is marked with the smallest tentative distance, and set it as the new "current node" then go back to step 3.

RESULTS AND DISCUSSION OF SIMULATION WORK

In our simulation, NS2 has been used. NS2 stands for network simulator version 2. It is a discrete event simulator which is targeted for networking research. It works at packet level and provides support for simulation of routing, multicast protocols and TCP over wired and wireless networks. It helps in verification of new protocols in less time.

It provides a suitable environment for designing new protocols, visualizing and creating the simulation under specific conditions and analyzing the results. Various parameters used in our simulation is given below.

Table 1: Simulation Parameters

Parameter	Value
Simulator	NS-2
Simulation Duration	150 sec
Topology	1000 meter X 1000 meter
No. of nodes	100
Link Cost	10
Traffic type	FTP(tcp)
Routing Protocol	HWMP
Channel Number	50

Parameters Used for Comparison

Throughput

It is the average rate of successful message delivery over a communication channel in a given amount of time. The throughput is measured in kilo bits per second (Mbps). Greater is the value of throughput means better is the performance of the protocol.

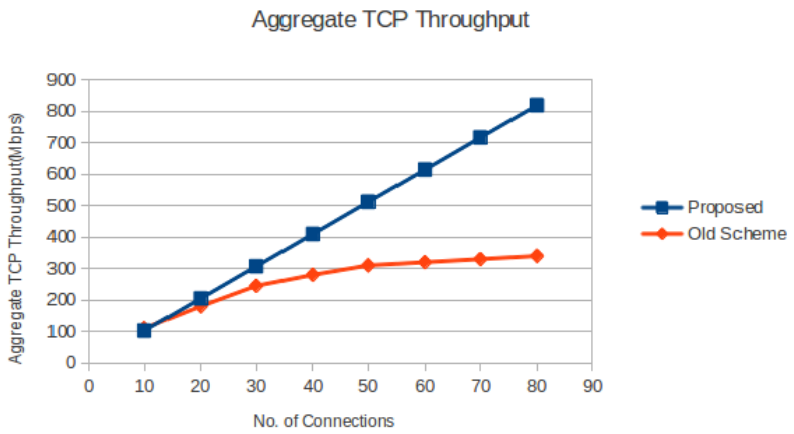

Figure 3: Comparison of Throughput of Proposed Scheme with Old Scheme

Packet Overhead

Maximum time taken by the packet transmission on the network. It reduces the overall transmission speed of the raw data. Lower the value of the packet overhead means better the performance of the protocol. The overhead is measured in bytes.

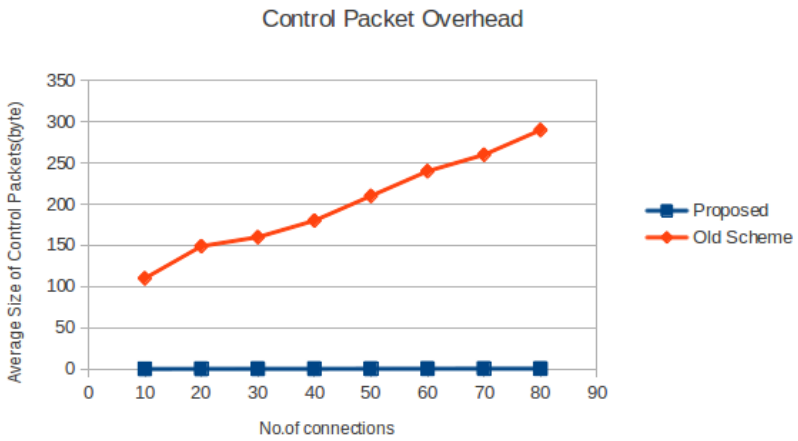

Figure 4: Comparison of Packet Overhead of Proposed Scheme with Old Scheme

End-to-End Latency

It refers to the delay between signal or packet originating at the transmitting end and when it is received at the other end. Lower the value of the end-to-end latency means greater the performance of the protocol.

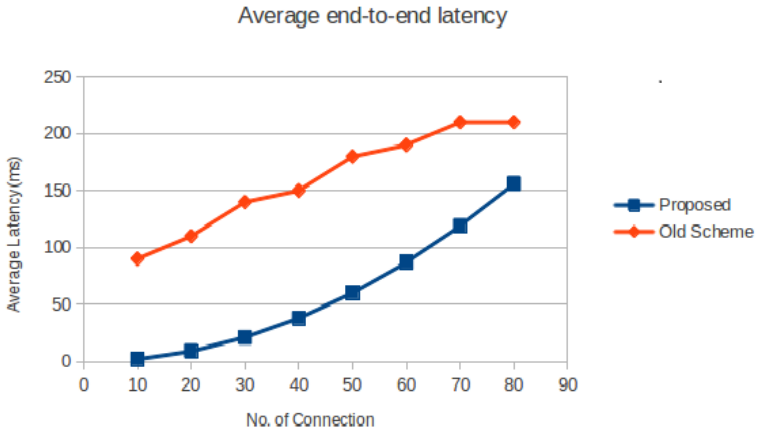

Figure 5: Comparison of Latency of Proposed Scheme with Old Scheme

CONCLUSIONS

WLAN Mesh Network has been considered a good framework for future wireless infrastructure. But, the current standards do not focus on the reduction of control packet overhead in MIMC environment. In this paper, we have built a new routing protocol that works to reduce the control packet overhead by increasing the time intervals of the PREQ forwarding packet and also we include link cost and channel diversity according to the dijkstra's algorithm to attain better network performance than the previous work. The proposed work mainly focuses on the throughput, end-to-end latency and packet overhead. Finally, we attain the better network performance than the previous proposed scheme. Future works would introduce energy parameter so that we may calculate network lifetime in contrast to consumption of battery life for the forwarding packet nodes.

REFERENCES

1. A. P. Subramanian, M. M. Buddhiko, and S. Miller, "Interference aware routing in multi-radio wireless mesh networks ," IEEE Workshop on Wireless Mesh Networks (WiMesh), 2006.
2. M.-J. Lee, J. Zheng, Y.-B. Ko and D. M. Shrestha, "Emerging Standards For Wireless Mesh Technology," IEEE Wireless Communications, Vol.13, Issue 2, Apr. 2006, pp.56-63.

3. H. Skalli et al. “Channel Assignment Strategies for Multiradio Wireless Mesh Networks: Issues and Solutions,” IEEE Communications Magazine, Nov. 2007.

4. P. Pandey, S. Satish, J. Kuri, and H. Dagale, “Design & implementation of IEEE 802.11s mesh nodes with enhanced features,” Mobile Adhoc and Sensor Systems (MASS), 2009.

5. D. Wu and P. Mohapatra, “From Theory to Practice: Evaluating Static Channel Assignments on a Wireless Mesh Network,” IEEE Conference on Computer Communications (InfoCom) Mini-Conference, 2010.

6. G.Qijun ,Y.Meng and Z.Wanyu, “Lightweight Attacks against Channel Assignment Protocols in MIMC Wireless Networks”IEEE Communications Society, 2011.